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(54) **REINFORCING MASONRY STRUCTURES**

VERSTÄRKUNG VON MAUERWERKSTRUKTUREN

REINFORCEMENT DE STRUCTURES DE MA ONNERIE

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(73) Proprietors:
• **Protec Industrial Ltd.**
Maidstone, Kent ME17 3EH (GB)
• **SSP Consulting Civil & Structural Engineers Ltd.**
Queensborough, Isle of Sheppey ME11 5JF (GB)

(72) Inventor: **BOUGHTON, Brian, SSP Consulting**
Queenborough, Isle of Sheppey ME11 5JF (GB)

(74) Representative: **Brookes Batchellor**
102-108 Clerkenwell Road
London EC1M 5SA (GB)

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Description

[0001] This invention is concerned with techniques for reinforcing masonry structures, especially arched structures such as bridges.

[0002] It has already been proposed, for example in GB-A-2 249 120, to reinforce masonry walls by embedding reinforcing rods in the horizontal bedding joints of the wall. The internal forces encountered in arches make the reinforcement of an arched structure a much more complicated task than that involved in reinforcing walls alone.

[0003] A paper entitled "Testing of Small Scale Masonry Arch Bridges with Surface Reinforcement" published in Volume 1 of the Proceedings of the Sixth International Conference and Structural Faults and Repair (Extending the Life of Bridges), London, July 1995, describes testing a model bridge in which the arch has been reinforced longitudinally and transversely with surface mounted straps. The paper proposed that, in a real structure, the straps would be replaced with reinforcing bars grouted into precast grooves in the exposed masonry. Such a system is also proposed in GB-A-2 302 896 filed 1 July 1995 but not published until 5 February 1997.

[0004] US-A-4,705,841 discloses epoxy-urethane resins that can be used as adhesives and joint sealants.

[0005] The present invention provides a method of reinforcing a masonry arch or bridge comprising forming grooves longitudinally and transversely in the intrados, and embedding reinforcing rods or bars in a grouting composition in the grooves, characterised in that the transverse rods or bars reinforcing the intrados are laid against a first layer of longitudinal rods or bars and a second layer of longitudinal rods or bars are laid against the transverse rods.

[0006] More specifically, with regard to contracting state GB, the invention is characterised by placing a first layer of longitudinal rods or bars in the longitudinal grooves, placing an intermediate layer of transverse rods or bars in the transverse grooves across the first layer, and placing a second layer of longitudinal rods or bars in the existing longitudinal grooves across the intermediate layer.

[0007] When reinforcing a masonry arch, the above treatment of the intrados is preferably supplemented by forming substantially horizontal grooves in the masonry above the arch, forming substantially vertical grooves in the masonry at each side of the arch, and embedding a reinforcing rod or bar in a grouting composition in each groove. It is advantageous to allow at least one of the vertical grooves to overlap with at least one horizontal groove, so that the respective reinforcing rods also overlap and may be tied to each other to increase the reinforcement.

[0008] In the context of reinforcing a masonry arch bridge, the additional treatment preferably comprises forming substantially horizontal grooves in each parapet

and forming substantially vertical grooves in each spandrel and/or wing wall, embedding a reinforcing rod or bar in a grouting composition in each groove.

[0009] The horizontal grooves are normally formed in the outer surface of each parapet, and the vertical grooves are in the outer surfaces of the spandrels and/or wing walls. In this configuration it is advantageous to allow at least one of the vertical grooves on each side of the arch ring to overlap with at least one horizontal groove, so that the respective reinforcing rods also overlap and are tied in to each other by the grout to increase the reinforcement.

[0010] Vertical grooves may also be formed above the arch, or in the parapet of a bridge, to cross the horizontal grooves, to provide further overlapping reinforcement when rods are embedded in the grooves. Advantageously further grooves are formed extending radially outwards from the arch ring to cross the horizontal and/or vertical grooves, as formed in the parapet, spandrel and/or wing walls in the case of a bridge. Preferably these further grooves extend substantially normal to a tangent to the arch ring at the point at which the groove starts from the arch ring.

[0011] In the context of a bridge, this allows reinforcing rods embedded in those grooves to tie the intrados reinforcing network to the network of rods on the outer vertical surface of the bridge. For example, by using rods or bars that are 'L'-shaped, the short arm of the 'L' may be overlapped with the end of a transverse bar.

[0012] The grooves that receive the reinforcing rods or bars may be cut into the masonry, preferably utilising bedding joints where possible. Alternatively, where practicable, they may be formed by raking out bedding joints, most suitably for horizontal grooves in the parapet. Typically these bedding joints lie parallel to the line of the parapet, and so may not be truly horizontal throughout their length.

[0013] The reinforcing rods or bars are preferably embedded by first injecting into the groove a backing bead of grout. The rod is pressed into the bead and then further grout is injected to complete the embedment. When one rod is laid so as to cross or overlap another rod, the grout embedding the underlying rod is preferably scraped away at the junction before laying the overlying rod, to allow satisfactory tying in.

[0014] The reinforcement is preferably carried out using steel, especially stainless steel, rods. The rods may be shaped, for example of helical form or with protruding tabs, or roughened to provide a good key to the grout. Also bars may be used, and the bars may be shaped, for example angle bars, or slotted or apertured to improve the key. Alternatively other high strength reinforcing materials, such as rods of carbon fibre reinforced resin, may be used.

[0015] The grout may be based on a synthetic resin, such as epoxy, or of a conventional cementitious composition. In a preferred implementation of the method of the invention, the grout is formulated so that it remains

flexible when set or cured, and so that it has a compressive strength comparable to the surrounding masonry. In a still further preferred embodiment, the grout is formulated so that it is of low density, to reduce the risk of the grout sagging or slumping as it cures in downwardly facing grooves such as in the intrados of a masonry arch. Low density may be achieved by incorporating lightweight fillers, such as hollow glass beads or microspheres. According to another aspect of the invention a particularly suitable grout is formulated to provide a epoxy/urethane hybrid resin on curing, according to attached claim 9. This provides good adhesion to steel bars and to masonry, is flexible on curing and can be formulated to low density and appropriate compressive strength by incorporating a hollow glass bead filler.

[0016] Since a bridge in a state of disrepair is often of historic or architectural merit, it may be appropriate to colour the grout, or to finish the grooves with a coloured pointing composition to match the original pointing. In some parts of the bridge structure it may be possible to prepare brick slips from bricks matching the original masonry, and so hide the filled grooves with an outer layer of slips.

[0017] An embodiment of the invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side elevation of a masonry arch bridge with reinforcement applied;

Fig. 2 is a sectional view along the line A-A of Fig 1;

Fig. 3 is an enlarged partial cross-section of the area B shown in a broken circle in Fig 2;

Fig. 4 is an enlarged partial cross-section of the area C shown in a broken circle in Fig 2;

Fig. 4a is a similar view to Fig 4, showing use of a tie bar;

Fig. 5 is a schematic isometric view of part of the reinforcement network in the bridge shown in Fig. 1.

[0018] The method of this invention will often be used on bridges in an advanced state of disrepair. Therefore it may well be appropriate, in addition to reinforcement with metal rods or bars in accordance with this invention, to stabilise the barrel by pressure grouting a cement-based thixotropic non-shrink grout through the open joints where the original joints and pointing have eroded and washed out over the years.

[0019] Fig 1 is a side elevation of a typical masonry bridge as found on the canal systems of the United Kingdom. The bridge has an arch ring 1 bounded by spandrels 2 and wing walls 3. The bridge carries a roadway protected by parapets 4. Whilst the initial stabilisation grouting works are in progress, the preparation and in-

stallation of the system to the outer parapets, wing walls and spandrels can be carried out simultaneously as follows.

[0020] After erecting scaffolding to allow for safe working platforms on both sides of the bridge, profile strips, typically of 6mm x 75mm plywood, are fixed to the outer face of brickwork, for example fixed by 50mm screws and plugs, adjacent to the intended cut line, preferably along a horizontal joint. With a cutter, such as a double diamond bladed wall chaser, and using the profile timber as a guide, a cut is made into the joint approximately 50mm deep. A bolster or plugging chisel is used to carefully snap off the cored plug to leave a clean cut rebate approximately 10-15mm wide x 50mm deep centred on the horizontal bed joint. This is repeated as desired to form a series of substantially horizontal grooves 10 extending along the line of the parapet.

[0021] Using the same techniques as described above, only cutting vertically through the perpendicular joints where possible but also through the brick face of stretcher and header courses if needed, a series of substantially vertical grooves 11 are formed from the wing walls to the parapet.

[0022] All loose, friable material and dust is flushed out from the grooves, cut as above, with clean water. While the groove is still damp, a priming coat is applied by brush. A typical primer consists of a synthetic polymer, such as Ronafix SBR (styrene-butadiene rubber), and cement mixed in the ratio of 1:1. This is applied to the back of the cut rebates. Then, typically using a single diaphragm grout pump or a pressurised pointing vessel gun, an approximately 10mm thickness of grout is applied along the back face of the primed grooves. The grout may be a, preferably thixotropic, cement grout such as ABP "Thixopump".

[0023] However, as mentioned above, preferred grouts are based on an epoxy/urethane hybrid resin, in which urethane linkages flexibilise an epoxy base resin. Such materials may be formulated as a two component grout, comprising a hardener component based on a polyamine, especially a cycloaliphatic polyamine, such as poly-cyclohexylamine, and a polymerisable resin component which is a blend of an epoxy resin, especially a bisphenol A and/or bisphenol F epoxy, with a blocked isocyanate. Each component can be filled with glass microspheres to form solvent-free compositions that can be easily blended on site in a simple 1:1 ratio to form a non-slumping, easily pumpable, structural adhesive.

[0024] A typical system has a specific gravity of about 0.89, and develops a compressive strength of about 11 N/mm² after 24 hours, rising to about 21 N/mm² after 7 days. The compressive strength can be varied to adapt to the masonry under reinforcement by adjustment of the filler content. Suitable grout formulations are manufactured by NUFINS Ltd under the designation MARS structural adhesive. A structural adhesive of this type can be used as a grout without the need for a primer, if

used on surfaces that are reasonably clean and dry.

[0025] To secure the parapets to the wing walls and spandrels reinforcing rods or bars 10' are inserted initially into the grooves 10 and pressed into the backing bead of grout, and then similarly rods 11' into the grooves 11. Preferably, some of the vertical rods 11a' are laid across the horizontal rods, to tie the reinforced areas to each other.

[0026] Again by pressure grouting, more grout is fed into the grooves to completely encapsulate the reinforcing rods or bars in the grooves. This secondary grout is kept short so as to allow for reinforcing laps to be described below, as indicated on the accompanying drawings. Also the secondary layer of grout is raked back by about 15mm to 20mm behind the brick face to allow for the repointing of the joints to match the existing brickwork.

[0027] Additionally, as soon as the secondary grout layer has reached a firm enough set, the stretcher and header brick faces may be carefully removed by hand (hammer and chisel). 20mm brick slips, cut from bricks to match the existing bricks may be set into place with an epoxy adhesive along the previously cut rebate. These remedial works will camouflage the intrusion of the reinforcement into the pre-existing structure.

[0028] Whilst the works as described are in progress, it is desirable to carry out temporary works to stabilise the barrel during the insertion of the reinforcing system of this invention. As shown in Fig 2, to stabilise the brickwork locally adjacent to the intended cutting lines, steel hoop-shaped straps 12 of about 50 x 5mm section are fixed to the barrel 13 and abutments 14. The straps can be predrilled to accept a No. 10 screw fixing at about 750mm centres, and are fixed by being screwed through the joint or brick about 65mm deep.

[0029] Using the edge of the straps 12 as a cutting profile where possible, cuts are made longitudinally 15 and transversely 16 of the intrados using the techniques described above. On completion of the cuts, and leaving the steel straps in position, the core plugs are removed as described before. For overhead work it may be desirable to construct a cradle within the arch to provide a mounting rail on which the cutter can be supported as it is tracked across the intrados. The cradle also acts as a guide rail to provide a smoothly arcuate bed to the cut groove in situations where the intrados has an undulating surface.

[0030] After preparation of the grooves, longitudinal reinforcing rods 15' are installed with initial backing and encapsulating grout all as before described. The grout is raked out to expose the rods 15' at the intended intersection with subsequently applied transverse rods to allow for embedment.

[0031] As soon as the grout has reached its a satisfactory set (usually about 24 hrs), the steel strapping may be shifted to allow further rod positions to be prepared. On final set, the steel straps can be removed with any subsequent loading being transferred to the longi-

tudinal rods.

[0032] Using similar techniques, further reinforcement rods 16' are placed transversely across the barrel and installed as before described. To prevent the rods 16' from falling downwards out of the grooves, it may be desirable to attach the transverse rods 16' to the previously applied longitudinal rods 15', using steel wire. Subsequently a second longitudinal rod 15' is installed in each groove 15, with occasional wiring to the transverse rods, so that each transverse rod 16' is sandwiched between a longitudinal rod 15' installed initially and the second longitudinal rod 15', as seen in Figs 4 and 5.

[0033] It may be appropriate to pin the rods into the grooves, using steel tie bars with hooked ends, as shown in Fig 4a. Preferably at the intersection of longitudinal grooves 15 and transverse grooves 16, a bore 20 is drilled into the arch ring to receive a tie bar 20'. The tie bar is secured in position, for example with a thixotropic resin, with its hooked end located around a rod to be secured, such as an outermost longitudinal bar 15". In addition to extending the reinforcing matrix, the tie bars retain the rods 15', 16', 15" in position in the grooves 15, 16 until the grout has set.

[0034] The grout length is kept short at each end of the transverse rods to allow for insertion of continuity 'L' rods 17', in grooves 17, or possibly bores, cut or drilled in the parapet, wing walls and/or spandrels substantially radially to the curve of the arch ring, as seen in Figs 2 and 5. The short arm of the 'L' is lapped against the end of one of the transverse rods laid in the intrados, so connecting the barrel to the wing wall and spandrels. The grooves or bore are filled with grout as before. These linking grooves are typically cut from the arch ring into the vertical surfaces of the bridge along a line that is substantially normal to the tangent to the arch ring at the point where the rod 17' will be lapped with a transverse rod 16'.

[0035] As shown in Fig 4, an upright groove 17 may be cut into the parapet, and if necessary continued by a bore 18 through coping stones. This allows an 'L'-shaped rod 17' to be inserted in the groove and bore with its other arm lapped with a transverse rod 16'. Alternatively protruding ends of an over-length transverse rod 16' may be turned upwards to lie in a groove 17. After injection of grout, the groove 17 may be masked by a cover of brick slips 19.

[0036] Because of the close proximity to each other, centre to centre, of the longitudinal rods it is often not possible to remove the intruded brick face of the intrados and replace it with slip bricks, as described for the wing walls and parapet. To disguise the intrusion, it is possible to completely fill the rebate with grout, struck level to the brick surface, or endeavour to match the brick colour by adding a colour dye to the grout.

[0037] The reinforcing rods are suitably 6mm stainless steel rods, typically stainless steel grade 304515, but other corrosion resistant rods or bars, for example,

carbon fibre rods, may be used if appropriate. The re-pointing described above may be carried out by applying 1:2:9 opc:lime:sand mortar (to BS 5628) to match existing pointing.

Claims

Claims for the following Contracting State : GB

1. A method of reinforcing a masonry arch or bridge comprising forming grooves longitudinally (15,16) and transversely in the intrados, and embedding reinforcing rods or bars (15',16') in a grouting composition in the grooves, **characterised by** placing a first layer of longitudinal rods or bars (15') in the longitudinal grooves (15), placing an intermediate layer of transverse rods or bars (16') in the transverse grooves (16) across the first layer, and placing a second layer of longitudinal rods or bars (15') in the existing longitudinal grooves (15) across the intermediate layer.
2. A method according to claim 1 which comprises additionally forming substantially horizontal grooves (10) in the masonry above the arch, and embedding a reinforcing rod or bar (10') in a grouting composition in each groove.
3. A method according to claim 1 or 2 which comprises additionally forming substantially vertical grooves (11) in the masonry at each side of and/or above the arch, and embedding a reinforcing rod or bar (11') in a grouting composition in each groove.
4. A method according to claim 3 in which at least one of the vertical grooves (11) overlaps with at least one horizontal groove (10), so that the respective reinforcing rods also overlap.
5. A method according to claim 3 or 4 in which the masonry structure is a masonry arch bridge, which comprises forming substantially horizontal grooves (10) in each parapet (4) and forming substantially vertical grooves (11) in each spandrel (2) and/or wing wall (3) and/or parapet (4), and embedding a reinforcing rod or bar (10',11') in a grouting composition in each groove.
6. A method according to any one of claims 1 to 5 in which further grooves (17) are formed extending generally radially outwards from the arch ring to receive reinforcing rods or bars (17') that cross the horizontal (10) and/or vertical grooves (11).
7. A method according to claim 6 in which the radial reinforcing rods or bars (17') are "L" shaped and the

short arm is lapped with the end of a transverse bar (16') in the intrados reinforcing network.

8. A method according to claim 6 or 7 in which the further grooves (17) extend substantially normal to a tangent to the arch ring.
9. Use of an epoxy/urethane hybrid resin as a structural adhesive or grout to bond steel reinforcing bars into grooves in a masonry structure.
10. Use according to claim 9 in which the resin is formed by mixing a cycloaliphatic polyamine hardener with a blend of bisphenol A and bisphenol F epoxy resins with a blocked isocyanate.
11. Use according to claim 9 or 10 in which the resin contains a lightweight filler.
12. Use according to claim 11, in which the filler is hollow glass beads or microspheres.

Claims for the following Contracting States : AT, BE, DE, DK, ES, FR, IE, IT, NL

1. A method of reinforcing a masonry arch or bridge comprising forming grooves longitudinally (15,16) and transversely in the intrados, and embedding reinforcing rods or bars (15',16') in a grouting composition in the grooves, **characterised in that** the transverse rods or bars (16') reinforcing the intrados are laid against a first layer of longitudinal rods or bars (15') and a second layer of longitudinal rods or bars (15') are laid against the transverse rods (16').
2. A method according to claim 1 which comprises placing a first layer of longitudinal rods or bars (15') in the longitudinal grooves (15), placing an intermediate layer of transverse rods or bars (16') in the transverse grooves (16) across the first layer, and placing a second layer of longitudinal rods or bars (15') in the existing longitudinal grooves (15) across the intermediate layer.
3. A method according to claim 1 or 2 which comprises additionally forming substantially horizontal grooves (10) in the masonry above the arch, and embedding a reinforcing rod or bar (10') in a grouting composition in each horizontal groove (10) and/or additionally forming substantially vertical grooves (11) in the masonry at each side of and/or above the arch, and embedding a reinforcing rod or bar (11') in a grouting composition in each vertical groove (11).
4. A method according to claim 3 in which at least one of the vertical grooves (11) overlaps with at least

one horizontal groove (10), so that the respective reinforcing rods also overlap.

5. A method according to claim 3 or 4 in which the masonry structure is a masonry arch bridge, which comprises forming substantially horizontal grooves (10) in each parapet (4) and forming substantially vertical grooves (11) in each spandrel (2) and/or wing wall (3) and/or parapet (4), and embedding a reinforcing rod or bar (10', 11') in a grouting composition in each groove. 5
6. A method according to any one of claims 1 to 5 in which further grooves (17) are formed extending generally radially outwards from the arch ring to receive reinforcing rods or bars (17') that cross the horizontal (10) and/or vertical grooves (11). 10
7. A method according to claim 6 in which the radial reinforcing rods or bars (17') are "L" shaped and the short arm is lapped with the end of a transverse bar (16') in the intrados reinforcing network. 15
8. A method according to claim 6 or 7 in which the further grooves (17) extend substantially normal to a tangent to the arch ring. 20
9. Use of an epoxy/urethane hybrid resin as a structural adhesive or grout to bond steel reinforcing bars into grooves in a masonry structure. 25
10. Use according to claim 9 in which the resin is formed by mixing a cycloaliphatic polyamine hardener with a blend of bisphenol A and bisphenol F epoxy resins with a blocked isocyanate. 30
11. Use according to claim 9 or 10 in which the resin contains a lightweight filler. 35
12. Use according to claim 11, in which the filler is hollow glass beads or microspheres. 40

Patentansprüche

Patentansprüche für folgenden Vertragsstaat : GB

1. Verfahren zum Verstärken von Mauerwerkbogen oder -brücken, umfassend das Bilden von Längsnuten (15, 16) und Quernuten in den Gewölbelaibungen sowie das Einbetten von Verstärkungsstäben oder -stangen (15', 16') in eine Vergußmörtelverbindung in den Nuten, **dadurch gekennzeichnet, daß** eine erste Lage aus Längsstäben oder -stangen (15') in die Längsnuten (15) eingesetzt wird, daß eine Zwischenlage aus Querstäben oder -stangen (16') in die Quernuten (16) quer zur ersten 50

Lage eingelegt wird, und daß eine zweite Lage von Längsstäben oder -stangen (15') in die existierenden Längsnuten (15) quer zur Zwischenlage gelegt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** zusätzlich im wesentlichen horizontale Nuten (10) in das Mauerwerk oberhalb des Bogens eingebracht werden, und daß ein Verstärkungsstab oder eine Verstärkungsstange (10') in eine Vergußmörtelverbindung in jeder Nut eingebettet wird.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** weiterhin im wesentlichen vertikale Nuten (11) in das Mauerwerk beidseits und/oder oberhalb des Bogens gebildet werden, und daß ein verstärkender Stab oder eine verstärkende Stange (11') in eine Vergußmörtelverbindung in jeder Nut eingebettet wird.
4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, daß** wenigstens eine der vertikalen Nuten (11) wenigstens eine Horizontalnut (10) überlappt, so daß die entsprechenden Stäbe sich ebenfalls überlappen.
5. Verfahren nach Anspruch 3 oder 4, wobei die Mauerwerkstruktur eine Mauerwerkbogenbrücke ist, umfassend das Bilden von im wesentlichen horizontalen Nuten (10) in jeder Brüstung (4) sowie das Bilden von im wesentlichen vertikalen Nuten (11) in jedem Gewölbewinkel (2) und/oder in jeder Flügelwand (3) und/oder in jeder Brüstung (4), und daß ein verstärkender Stab oder eine verstärkende Stange (10', 11') in eine Vergußmörtelverbindung in jeder Nut eingebettet wird.
6. Verfahren nach einem der Ansprüche 1 bis 5, wobei weitere Nuten (17) gebildet werden, die sich im wesentlichen radial nach außen vom Bogenring erstrecken, um Verstärkungsstäbe oder Verstärkungsstangen (17') aufzunehmen, die die horizontalen (10) und/oder die vertikalen (11) Nuten kreuzen. 45
7. Verfahren nach Anspruch 6, wobei die radialen Verstärkungsstäbe oder -stangen (17') L-förmig sind, und der kurze Schenkel das Ende eines Querstabes (16') im Verstärkungsnetzwerk der Gewölbelaibung überlappt.
8. Verfahren nach Anspruch 6 oder 7, wobei die weiteren Nuten (17) sich im wesentlichen senkrecht zu einer Tangente an den Bogenring erstrecken.
9. Verwendung eines Epoxi-Urethan-Hybrid-Kunstharzes als struktureller Klebstoff oder Vergußmörtel

zum Binden von Stahlverstärkungsstäben in den Nuten eines Mauerwerks.

10. Verwendung nach Anspruch 9, wobei der Kunstharz dadurch gebildet wird, daß ein zykloliphatischer Polyaminhärter mit einem Gemisch aus Bisphenol A und Bisphenol F-Epoxi-Kunstharz mit einem neutralisierten Isocyanat gemischt wird. 5
11. Verwendung nach Anspruch 9 oder 10, wobei der Kunstharz einen Füllstoff geringen spezifischen Gewichtes enthält. 10
12. Verwendung nach Anspruch 11, wobei der Füllstoff aus hohlen Glaskugeln oder Mikrokugeln besteht. 15

Patentansprüche für folgende Vertragsstaaten : AT, BE, DE, DK, ES, FR, IE, IT, NL

1. Verfahren zum Verstärken eines Mauerwerkbogens oder einer Mauerwerkbrücke, umfassend das Bilden von Längsnuten (15, 16) und von Quernuten in der Gewölbelaibung sowie das Einbetten von Verstärkungsstäben oder -stangen (15', 16') in eine Vergußmörtelverbindung in den Nuten, **dadurch gekennzeichnet, daß** die Querstäbe oder -stangen (16'), die die Gewölbelaibung verstärken, auf eine erste Lage von Längsstäben oder -stangen (15') und eine zweite Lage von Längsstäben oder -stangen (15'') auf die Querstäbe (16') aufgelegt werden. 20 25
2. Verfahren nach Anspruch 1, umfassend das Auflegen einer ersten Lage von Längsstäben oder -stangen (15') in den Längsnuten (15), das Auflegen einer Zwischenlage aus Querstäben oder -stangen (16') in den Quernuten (16) quer zur ersten Lage, und das Auflegen einer zweiten Lage von Längsstäben oder -stangen (15') in den existierenden Längsnuten (15) quer zur Zwischenlage. 30 35 40
3. Verfahren nach Anspruch 1 oder 2, umfassend das zusätzliche Bilden von im wesentlichen horizontalen Nuten (10) im Mauerwerk oberhalb des Bogens sowie das Einbetten eines Verstärkungsstabes oder einer Verstärkungsstange (10') in einer Vergußmörtelverbindung in jeder horizontalen Nut (10) und/oder das zusätzliche Bilden von im wesentlichen vertikalen Nuten (11) im Mauerwerk beidseits und oberhalb des Bogens und das Einbetten eines Verstärkungsstabes oder einer Verstärkungsstange (11') in eine Vergußmörtelverbindung in jeder vertikalen Nut (11). 45 50
4. Verfahren nach Anspruch 3, wobei wenigstens eine der vertikalen Nuten (11) wenigstens eine horizontale Nut (10) überlappt, so daß auch die entspre-

chenden Verstärkungsstäbe einander überlappen.

5. Verfahren nach Anspruch 3 oder 4, wobei das Mauerwerk eine Mauerwerkbogenbrücke ist, umfassend das Bilden von im wesentlichen horizontalen Nuten (10) in jeder Brüstung (4) sowie das Bilden von im wesentlichen vertikalen Nuten (11) in jedem Gewölbewinkel (2) und/oder in jeder Flügelwand (3) und/oder in jeder Brüstung (4), und das Einbetten eines Verstärkungsstabes oder einer Verstärkungsstange (10', 11') in einer Vergußmörtelverbindung in jeder Nut. 5
6. Verfahren nach einem der Ansprüche 1 bis 5, wobei weitere Nuten (17) gebildet werden, die sich im wesentlichen radial nach außen vom Bogenring erstrecken, um verstärkende Stäbe oder -stangen (17') aufzunehmen, die die horizontalen (10) und/oder vertikalen (11) Nuten kreuzen. 10
7. Verfahren nach Anspruch 6, wobei die radialen Verstärkungsstäbe oder -stangen (17') L-förmig sind, und der kurze Schenkel das Ende eines Querstabes (16') im Verstärkungsnetzwerk der Gewölbelaibung überlappt. 20
8. Verfahren nach Anspruch 6 oder 7, wobei die weiteren Nuten (17) sich im wesentlichen senkrecht zu einer Tangente an den Gewölbering erstrecken. 25
9. Verwendung eines Epoxi-Urethan-Hybrid-Kunstharzes als Bauklebstoff oder als Vergußmörtel zum Binden von stählernen Verstärkungsstäben in Nuten in einer Mauerwerkkonstruktion. 30
10. Anwendung nach Anspruch 9, wobei der Kunstharz dadurch hergestellt wird, daß zykloliphatischer Polyaminhärter mit einem Gemisch von Bisphenol A und Bisphenol F-Epoxi-Kunstharzen mit einem neutralisierten Isozyanat gemischt wird. 35
11. Anwendung nach Anspruch 9 oder 10, wobei der Kunstharz einen Füllstoff geringen spezifischen Gewichtes umfaßt. 40
12. Anwendung nach Anspruch 11, wobei der Füllstoff aus hohlen Glaskugeln oder Mikrokugeln besteht. 45

Revendications

Revendications pour l'Etat contractant suivant : GB

1. Procédé de renfort d'une arche ou d'un pont de maçonnerie comprenant la formation de rainures longitudinalement (15, 16) et transversalement dans l'intrados, et l'incorporation de tiges ou barres de 55

- renfort (15', 16') dans une composition de jointoiement au mortier dans les rainures, **caractérisé en ce qu'il** comprend le placement d'une première couche de tiges ou barres longitudinales (15') dans les rainures longitudinales (15), le placement d'une couche intermédiaire de tiges ou barres transversales (16') dans les rainures transversales (16) croisant la première couche, et le placement d'une seconde couche de tiges ou barres longitudinales (15') dans les rainures longitudinales existantes (15) croisant la couche intermédiaire.
2. Procédé selon la revendication 1, lequel comprend la formation supplémentaire de rainures sensiblement horizontales (10) dans la maçonnerie au-dessus de l'arche, et l'incorporation d'une tige ou barre de renfort (10') dans une composition de jointoiement au mortier dans chaque rainure horizontale.
 3. Procédé selon la revendication 1 ou 2, lequel comprend la formation supplémentaire de rainures sensiblement verticales (11) dans la maçonnerie de chaque côté de l'arche et/ou au-dessus de cette arche, et l'incorporation d'une tige ou barre de renfort (11') dans une composition de jointoiement au mortier dans chaque rainure verticale.
 4. Procédé selon la revendication 3, dans lequel au moins l'une des rainures verticales (11) chevauche au moins une rainure horizontale (10), de sorte que les tiges de renfort respectives se chevauchent également.
 5. Procédé selon la revendication 3 ou 4, dans lequel la structure de maçonnerie est un pont à arche en maçonnerie, lequel comprend la formation de rainures sensiblement horizontales (10) dans chaque parapet (4) et la formation de rainures sensiblement verticales (11) dans chaque tympan (2) et/ou mur de culée (3) et/ou parapet (4), et l'incorporation d'une tige ou barre de renfort (10', 11') dans une composition de jointoiement au mortier dans chaque rainure.
 6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel d'autres rainures (17) sont formées, s'étendant d'une façon générale radialement vers l'extérieur depuis l'anneau de l'arche afin de recevoir des tiges ou barres de renfort (17') qui croisent les rainures horizontales (10) et/ou verticales (11).
 7. Procédé selon la revendication 6, dans lequel les tiges ou barres radiales de renfort (17') sont en forme de "L" et la branche courte est recouverte par l'extrémité d'une barre transversale (16') dans le réseau de renfort de l'intrados.
 8. Procédé selon la revendication 6 ou 7, dans lequel les autres rainures (17) s'étendent sensiblement perpendiculairement à une tangente à l'anneau de l'arche.
 9. Utilisation d'une résine hybride époxy/uréthane en tant qu'adhésif ou joint de structure afin de coller des barres de renfort en acier dans des rainures d'une structure en maçonnerie.
 10. Utilisation selon la revendication 9, dans laquelle la résine est formée en mélangeant un durcisseur de polyamide cycloaliphatique avec un mélange de résines époxy de bisphénol A et de bisphénol F avec un isocyanate bloqué.
 11. Utilisation selon la revendication 9 ou 10, dans laquelle la résine contient une charge légère.
 12. Utilisation selon la revendication 11, dans laquelle la charge est constituée de perles ou de microsphères de verre creuses.
- Revendications pour les Etats contractants suivants : AT, BE, DE, DK, ES, FR, IE, IT, NL**
1. Procédé de renfort d'une arche ou d'un pont de maçonnerie comprenant la formation de rainures longitudinalement (15, 16) et transversalement dans l'intrados, et l'incorporation de tiges ou barres de renfort (15', 16') dans une composition de jointoiement au mortier dans les rainures, **caractérisé en ce que** les tiges ou barres transversales (16') renforçant l'intrados sont étendues contre une première couche de tiges ou barres longitudinales (15') et **en ce qu'une** seconde couche de tiges ou barres longitudinales (15") sont étendues contre les tiges transversales (16').
 2. Procédé selon la revendication 1, lequel comprend le placement d'une première couche de tiges ou barres longitudinales (15') dans les rainures longitudinales (15), le placement d'une couche intermédiaire de tiges ou barres transversales (16') dans les rainures transversales (16) croisant la première couche, et le placement d'une seconde couche de tiges ou barres longitudinales (15') dans les rainures longitudinales existantes (15) croisant la couche intermédiaire.
 3. Procédé selon la revendication 1 ou 2, lequel comprend la formation supplémentaire de rainures sensiblement horizontales (10) dans la maçonnerie au-dessus de l'arche, et l'incorporation d'une tige ou barre de renfort (10') dans une composition de jointoiement au mortier dans chaque rainure horizontale (10) et/ou la formation supplémentaire de rainures

nures sensiblement verticales (11) dans la maçonnerie de chaque côté de l'arche et/ou au-dessus de cette arche, et l'incorporation d'une tige ou barre de renfort (11') dans une composition de jointoiement au mortier dans chaque rainure verticale (11).

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res de verre creuses.

4. Procédé selon la revendication 3, dans lequel au moins l'une des rainures verticales (11) chevauche au moins une rainure horizontale (10), de sorte que les tiges de renfort respectives se chevauchent également. 10
5. Procédé selon la revendication 3 ou 4, dans lequel la structure de maçonnerie est un pont à arche en maçonnerie, lequel comprend la formation de rainures sensiblement horizontales (10) dans chaque parapet (4) et la formation de rainures sensiblement verticales (11) dans chaque tympan (2) et/ou mur de culée (3) et/ou parapet (4), et l'incorporation d'une tige ou barre de renfort (10', 11') dans une composition de jointoiement au mortier dans chaque rainure. 15
20
6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel d'autres rainures (17) sont formées, s'étendant d'une façon générale radialement vers l'extérieur depuis l'anneau de l'arche afin de recevoir des tiges ou barres de renfort (17') qui croisent les rainures horizontales (10) et/ou verticales (11). 25
30
7. Procédé selon la revendication 6, dans lequel les tiges ou barres radiales de renfort (17') sont en forme de "L" et la branche courte est recouverte par l'extrémité d'une barre transversale (16') dans le réseau de renfort de l'intrados. 35
8. Procédé selon la revendication 6 ou 7, dans lequel les autres rainures (17) s'étendent sensiblement perpendiculairement à une tangente à l'anneau de l'arche. 40
9. Utilisation d'une résine hybride époxy/uréthane en tant qu'adhésif ou joint de structure afin de coller des barres de renfort en acier dans des rainures d'une structure en maçonnerie. 45
10. Utilisation selon la revendication 9, dans laquelle la résine est formée en mélangeant un durcisseur de polyamide cycloaliphatique avec un mélange de résines époxy de bisphénol A et de bisphénol F avec un isocyanate bloqué. 50
11. Utilisation selon la revendication 9 ou 10, dans laquelle la résine contient une charge légère. 55
12. Utilisation selon la revendication 11, dans laquelle la charge est constituée de perles ou de microsphères.

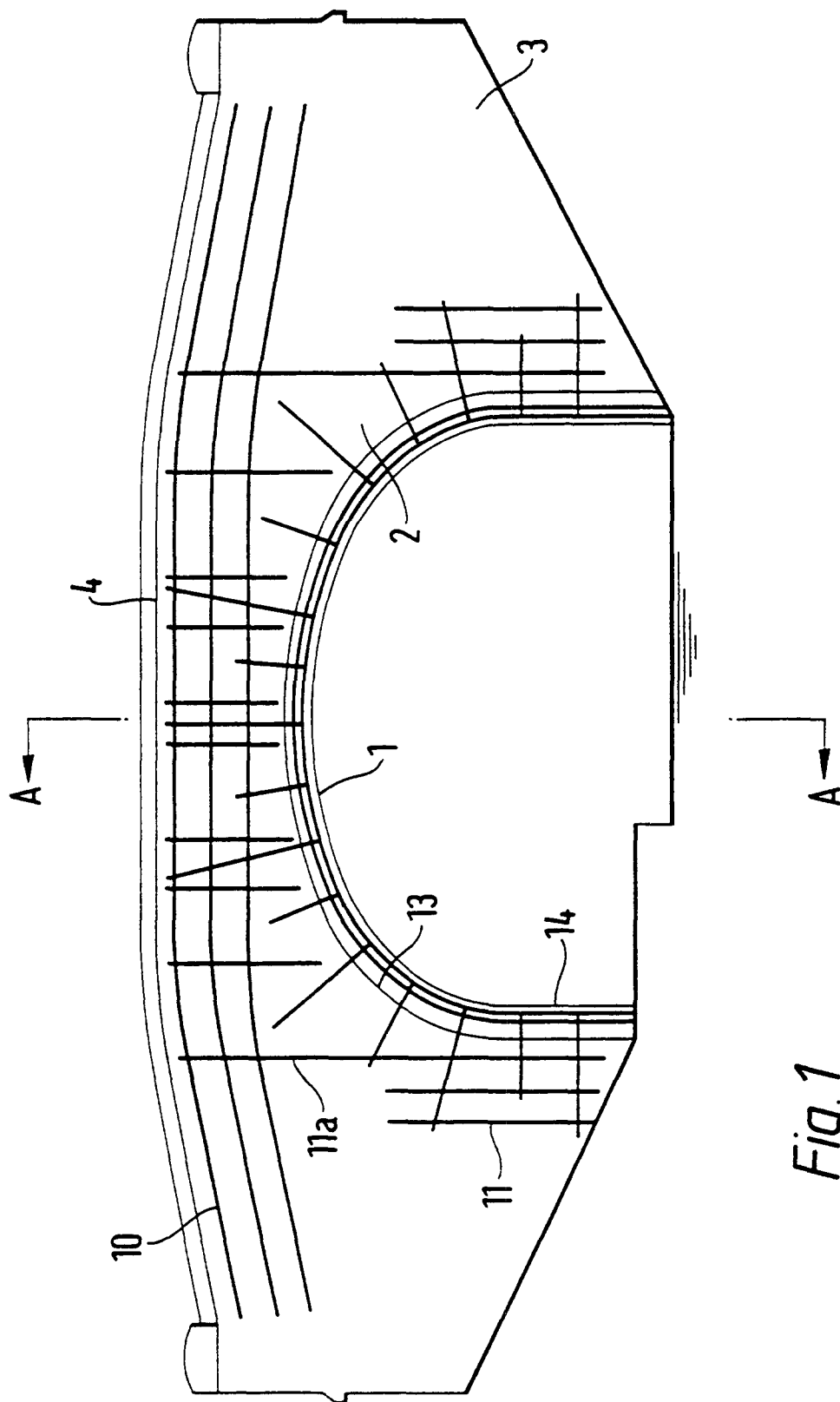


Fig. 1

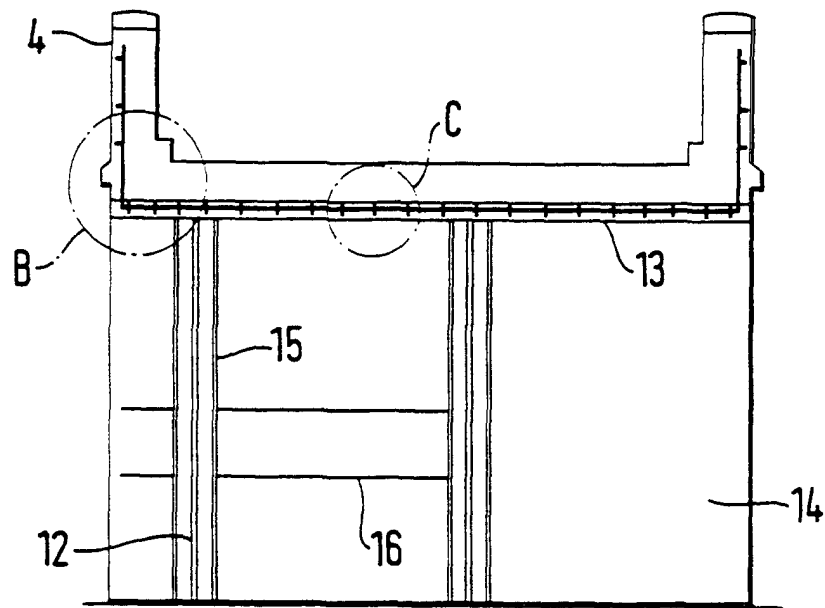


Fig. 2

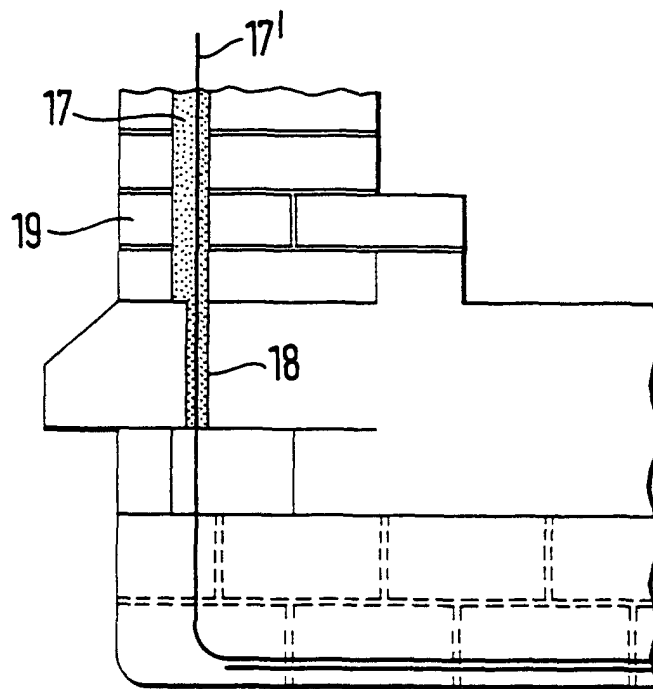


Fig. 3

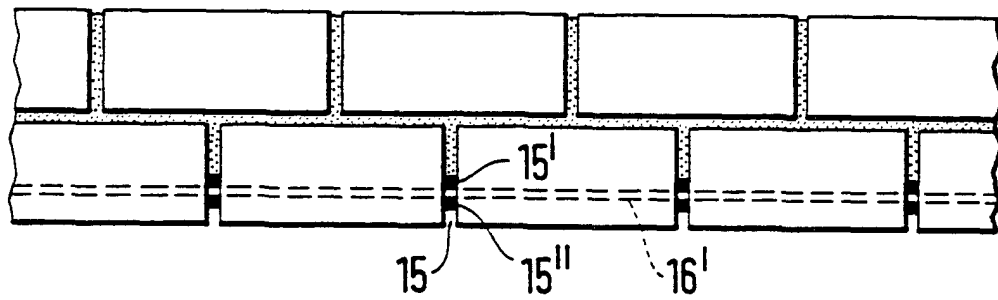


Fig. 4

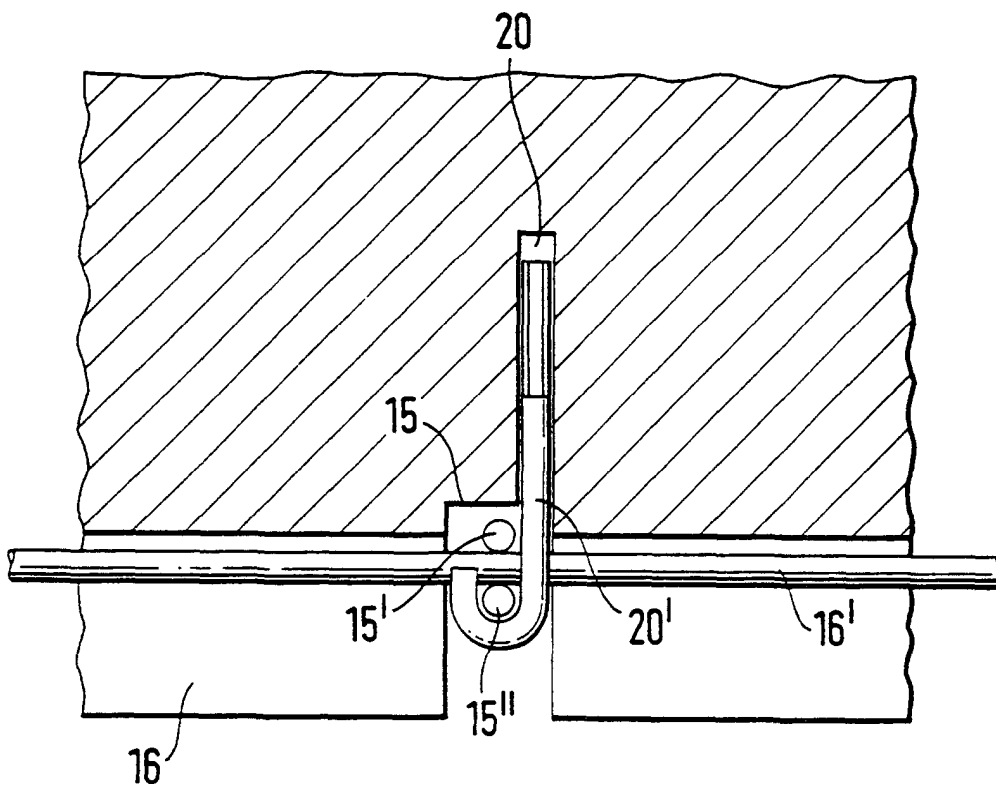


Fig. 4a

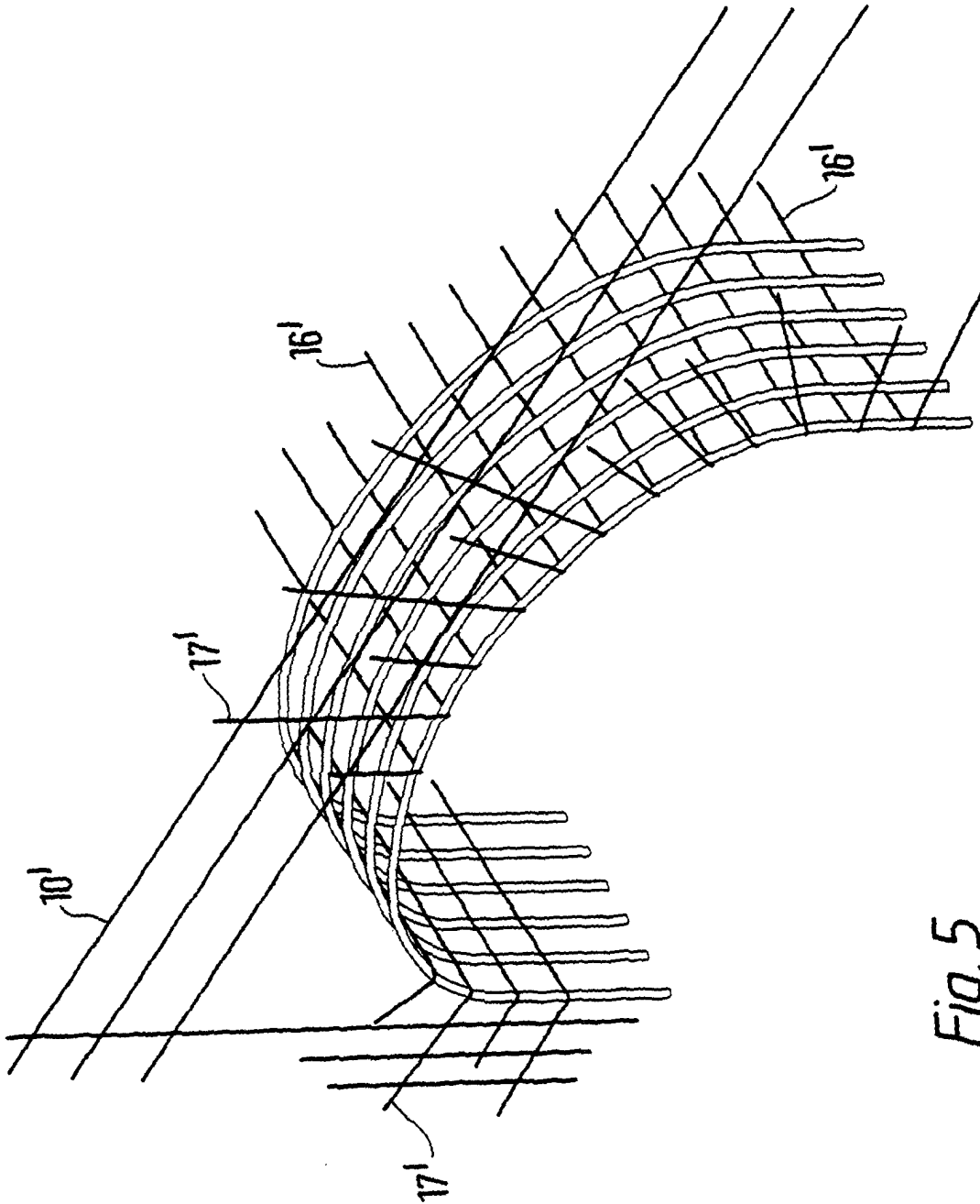


Fig. 5